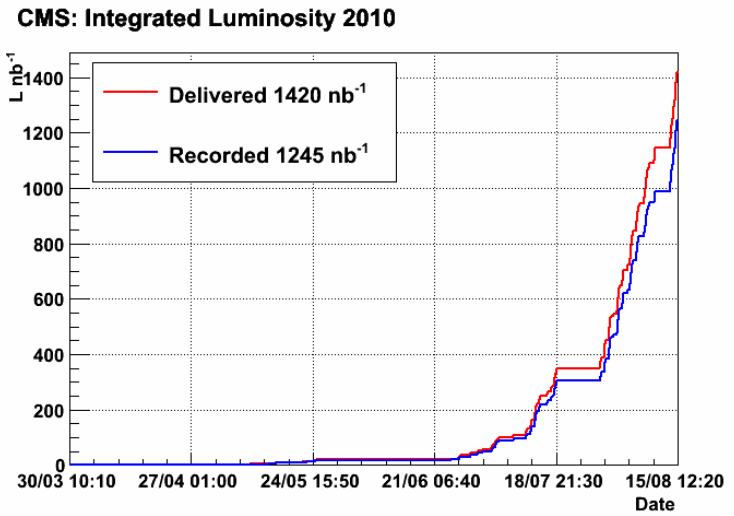
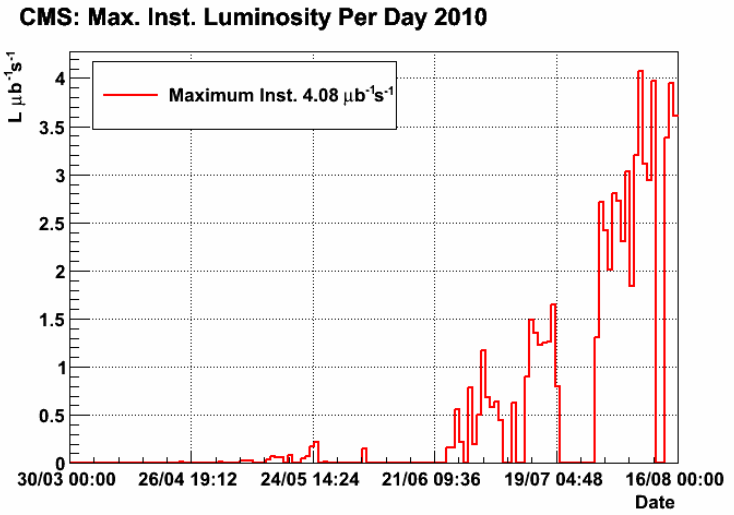
Status & Goals of LHC

- 1pb-1 of **delivered** and **recorded** luminosities reached!
- As of this morning:
  - Delivered: 1420 nb-1
  - Recorded: 1245 nb-1
- New record Inst. Luminosity of 4E30/cm2/s last week
- **Goal to reach 1E32/cm2/s by the end of 2010**
- **Integrated luminosity by end of 2011** ≥ 1 fb-1
  - **Requires a peak luminosity of ≥ 1E32/cm2/s during 2011**
- **Long Term Goal:**
  - Integrated luminosity of ≥3000fb^{-1} by the end of the LHC life
    - requires a peak luminosity of ≥ 5 x10^{34} cm^{-2}s^{-1} during 2021-2030
    - → integrated yearly luminosity of around 250-300fb^{-1}

LHC News (very broad-brush)

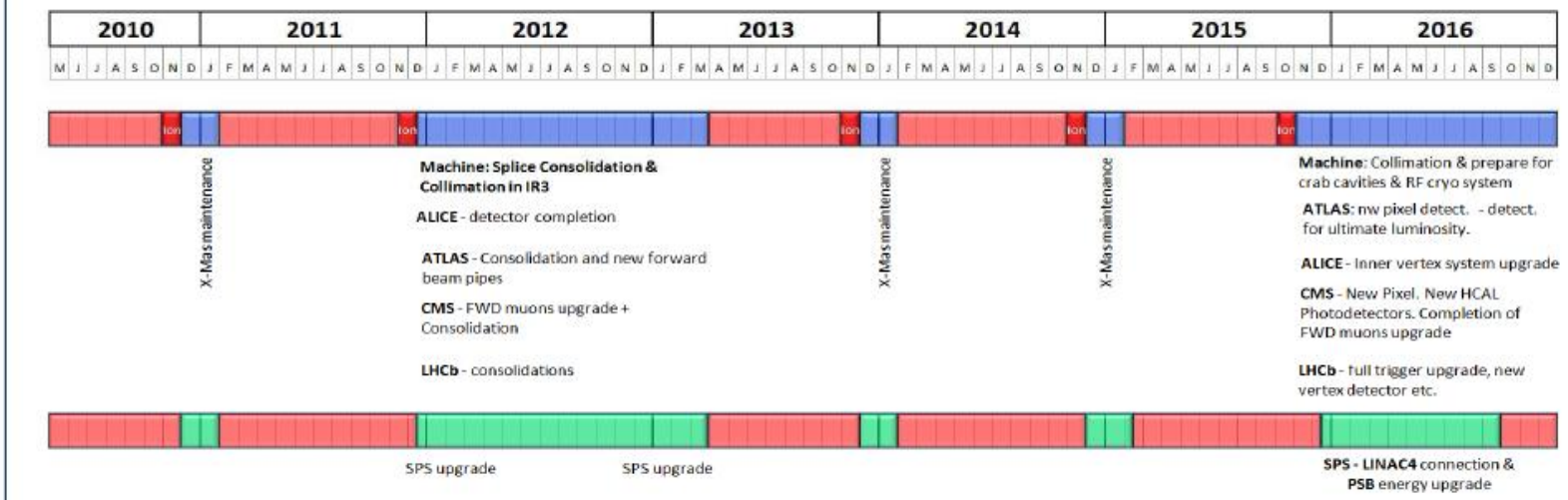
- Recently had longer periods of stable beams
  - CMS ~88% efficient recording data
    - ~100nb-1 per overnight fill
  - Aiming to maximize fraction validated for physics
    - Questions of sensitivity of analysis to hardware failures
- Waiting for news (this week) on rest of 2010 LHC planning
  - Recall aim is 1e32 by the end of the year
- Can expect to go to 48 on 48 bunches soon

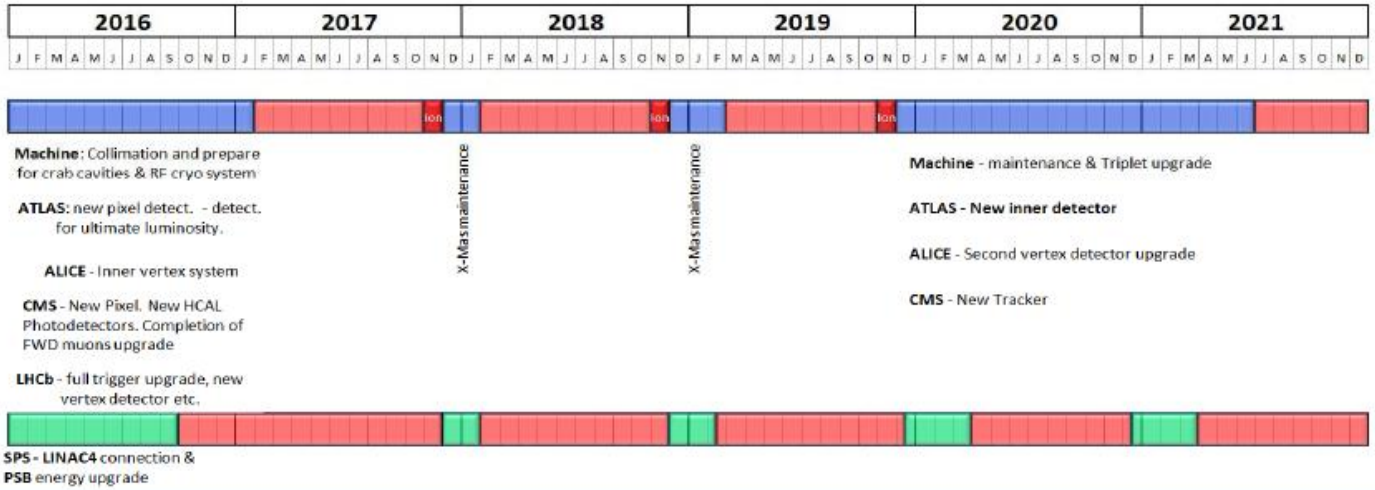




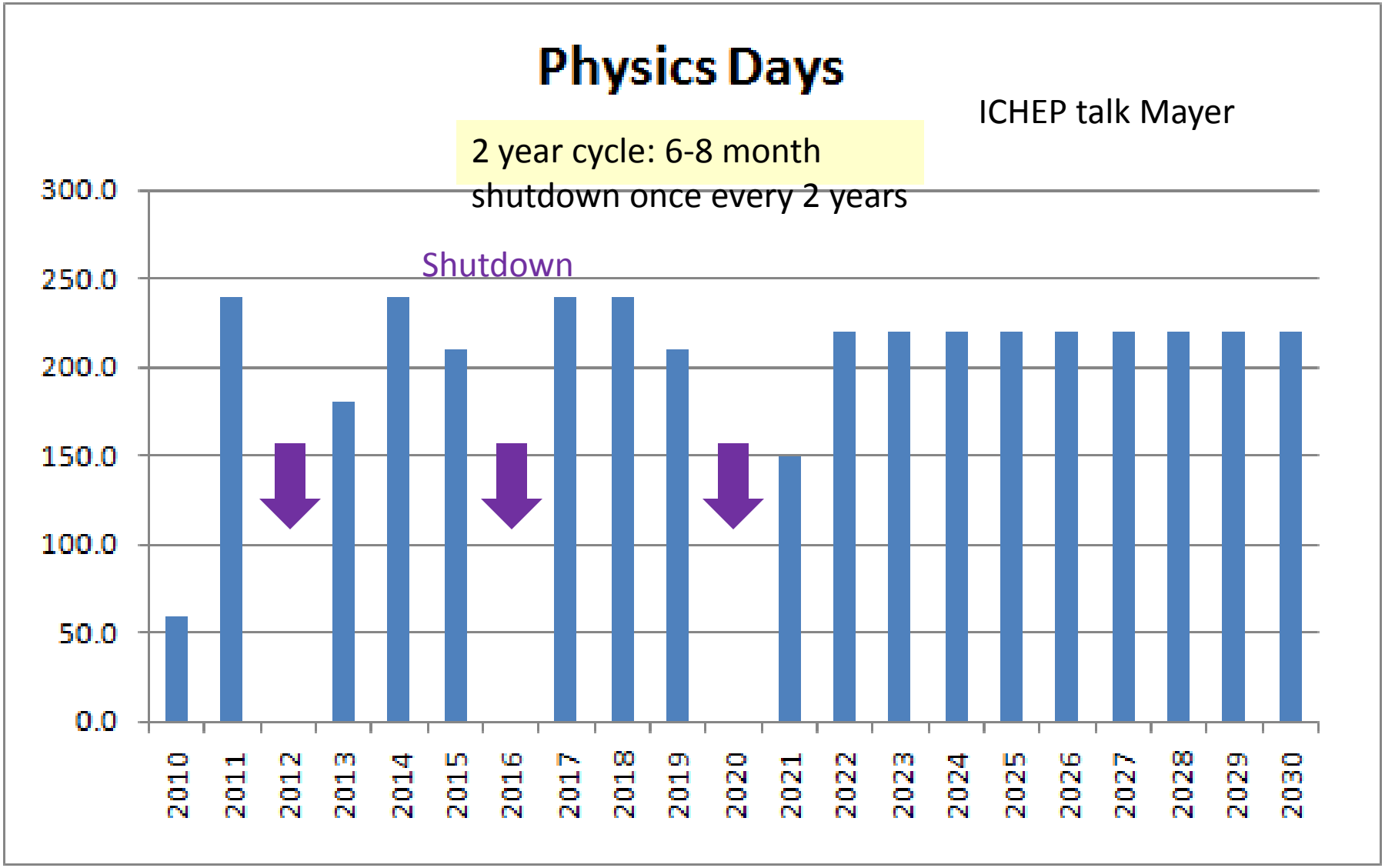
STEP	Nb	Nc	Ib	Itot	MJ	Increase	Peak lumi	Days	Int. Lumi	Approx date
4	3	1	1.E+11	3.0E+11	0.2	1.2	2.5E+29	5	0.032	W4 June
5	4	2	1.E+11	4.0E+11	0.2	1.3	5.1E+29	5	0.066	W1 July
6	8	4	1.E+11	8.0E+11	0.4	2.0	1.0E+30	5	0.13	W2 July
7	20	10	1.E+11	2.0E+12	**1.1**	2.5	2.5E+30	10	0.6	W3 & 4 July
8	24	24	1.E+11	2.4E+12	**1.3**	1.2	6.1E+30	20	3.2	August
9	48	48	1.E+11	4.8E+12	2.7	2.0	1.2E+31	10	3.1	September
10	96	96	1.E+11	9.6E+12	5.4	2.0	2.4E+31	10	6.2	September
11	144	144	1.E+11	1.4E+13	8.1	1.5	3.6E+31	10	9.3	October
12	192	192	1.E+11	1.9E+13	10.8	1.3	4.9E+31	10	12.7	October
13	240	240	1.E+11	2.4E+13	13.4	1.3	6.1E+31	7	11.1	November

The 10 year technical Plan





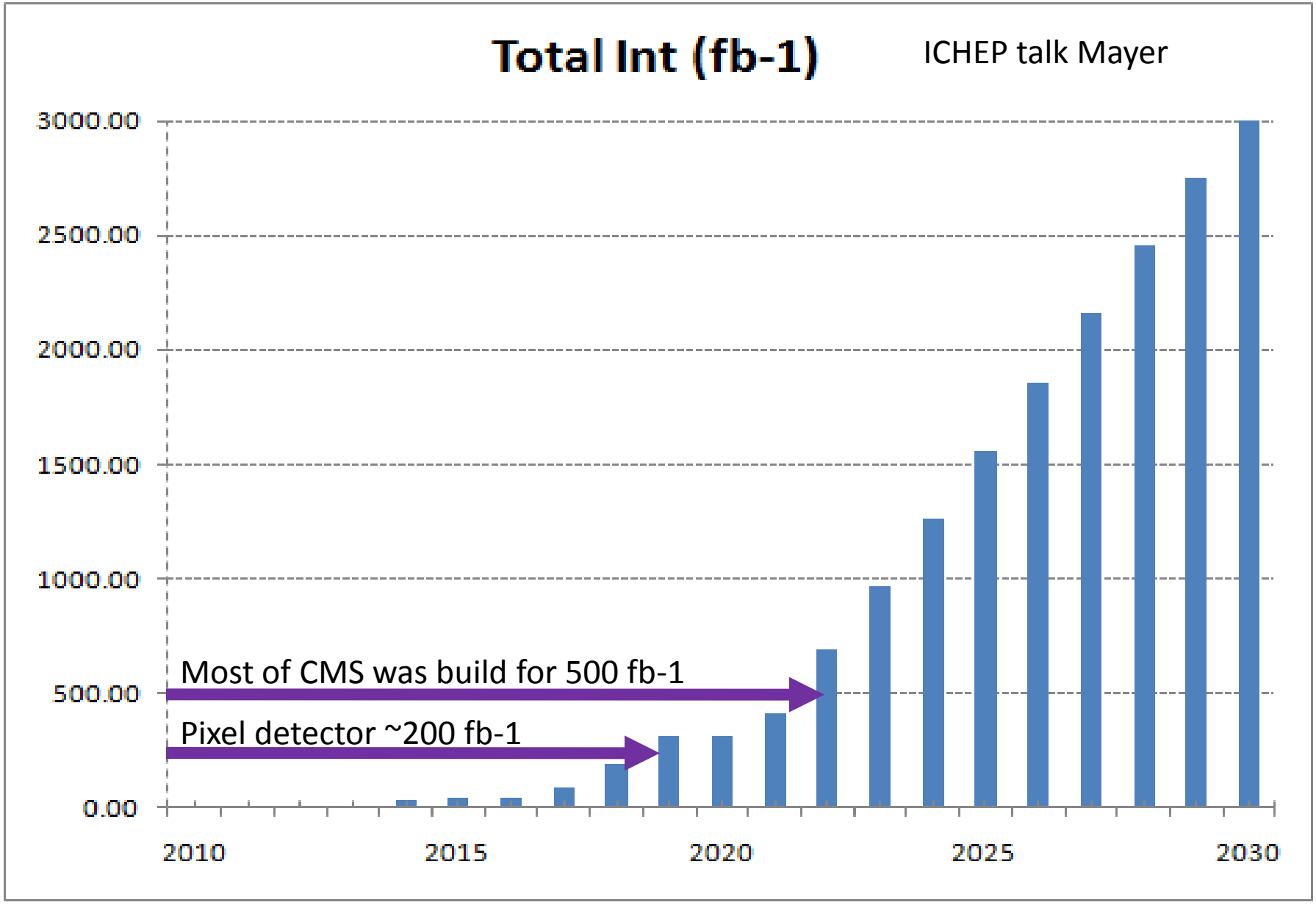
The 20 year physics plan



Luminosity Projection (ICHEP -S. Myers)

Year	TeV	OEF	β*	Nb	Ib	Itot	MJ	Peak luminosity	Pile up	pb-1/day	Physics Days	Integrated (fb-1/year)	Total Int (fb-1)
2010	3.50	0.20	2.00	796	8.0E+10	6.4E+13	36.0	1.886E+32	1.2643	3.3	20.0	0.1	0.07
2011	3.50	0.25	2.00	796	8.0E+10	6.4E+13	36.0	1.886E+32	1.2643	4.1	240.0	0.98	1.04
2012												0.0	1.0
2013	6.50	0.20	0.55	796	1.15E+11	9.2E+13	96.1	2.632E+33	17.6429	45.5	180.0	8.2	9.2
2014	7.00	0.20	0.55	1404	1.15E+11	1.6E+14	182.5	5.000E+33	19.0000	86.4	240.0	20.7	30.0
2015	7.00	0.20	0.55	2808	1.15E+11	3.2E+14	365.0	1.000E+34	19.0000	172.8	210.0	36.3	66.3
2016											0.0	0.0	66.3
2017	7.00	0.25	0.55	2808	1.15E+11	3.2E+14	365.0	1.000E+34	19.0000	216.0	240.0	51.8	118.1
2018	7.00	0.28	0.55	2808	1.50E+11	4.2E+14	476.1	1.701E+34	32.3251	411.6	240.0	98.8	216.9
2019	7.00	0.30	0.55	2808	1.70E+11	4.8E+14	539.6	2.185E+34	41.5198	566.4	210.0	118.9	335.8
2020											0.0	0.0	335.8
2021	7.00	0.20	0.30	2808	1.70E+11	4.8E+14	539.6	4.006E+34	76.1197	692.3	150.0	103.8	439.7
2022	7.00	0.27	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1257.3	220.0	276.6	716.3
2023	7.00	0.27	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1257.3	220.0	276.6	992.9
2024	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	1290.0
2025	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	1587.1
2026	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	1884.2
2027	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	2181.3
2028	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	2478.4
2029	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	2775.5
2030	7.00	0.29	0.25	2808	1.80E+11	5.1E+14	571.3	5.390E+34	102.4060	1350.5	220.0	297.1	3072.6

Luminosity predictions



CMS Upgrade planning

- The CMS improvement and upgrade strategy aims to maintain and possibly enhance the CMS physics potential.
  - Plans must be based on few shutdowns to install upgrades followed by long runs. Therefore in each case we must prepare for the luminosity that MIGHT BE ACHIEVED in the subsequent long run.
  - Luminosity evolution is difficult to predict
- Experience with first LHC data is valuable for CMS:
  - learn about radiation levels, cavern background, and trigger rates
  - detector performance and physics backgrounds

– CMS is developing a Technical Proposal for the evolution of the CMS detector through 2020. The TP will be completed in the summer for presentation to the LHCC.

– Assuming that the response is positive, we will proceed with a Technical Design report in 2011.

– There's already a declaration of interests from various countries.

– Preliminary cost and schedule also will be included in the Technical Proposal

Technical Proposal

- A Technical Proposal
  - States the physics case for a project or experiment outlining clearly the goals and requirements
  - It presents the general approach, possibly with options, to executing the project and provides evidence that the proposed approach will indeed successfully achieve the goals and satisfy the requirements
- A Technical Proposal is not a "Technical Design Report" (do not need a detailed design or even a unique solution)

CMS U1TDR
2010/08/03

2010/08/03
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Archive Tag: trunk

TECHNICAL PROPOSAL FOR THE EVOLUTION OF THE CMS DETECTOR THROUGH 2020

The Large Hadron Collider at CERN has begun operations at 7 TeV center of mass energy. CERN plans to run at this energy until the end of 2011 with the goal of providing an integrated luminosity of 1 fb^{-1} to the CMS and ATLAS experiments. The LHC will then shut down for 1 to 1.5 years to make the revisions necessary to run at ~14 TeV. Operation resumes in 2013. In 2015 or 2016, there will be another long shutdown to install the collimation required to operate at and above the design luminosity of 10^{34} cm^{-2} s^{-1}. Operation will then resume run with the luminosity rising gradually during this period to 2 10^{34} cm^{-2} s^{-1}. The two long shutdowns provide CMS an opportunity to carry out improvements to make the experiment more efficient, to repair problems that have been uncovered during operations, and to upgrade the detector to cope with the ultimate luminosity that will be achieved during this period. The detector work involves the hadron calorimeters, the muon detectors, the pixel detector, the beam radiation monitoring system, the luminosity measurement system, the trigger and the data acquisition system. The purpose of this report is to explain the physics motivations and describe the plans for carrying out these improvements, repairs and upgrades and installing them in the two shutdowns forseen in 2012-2013 and 2015-2016.

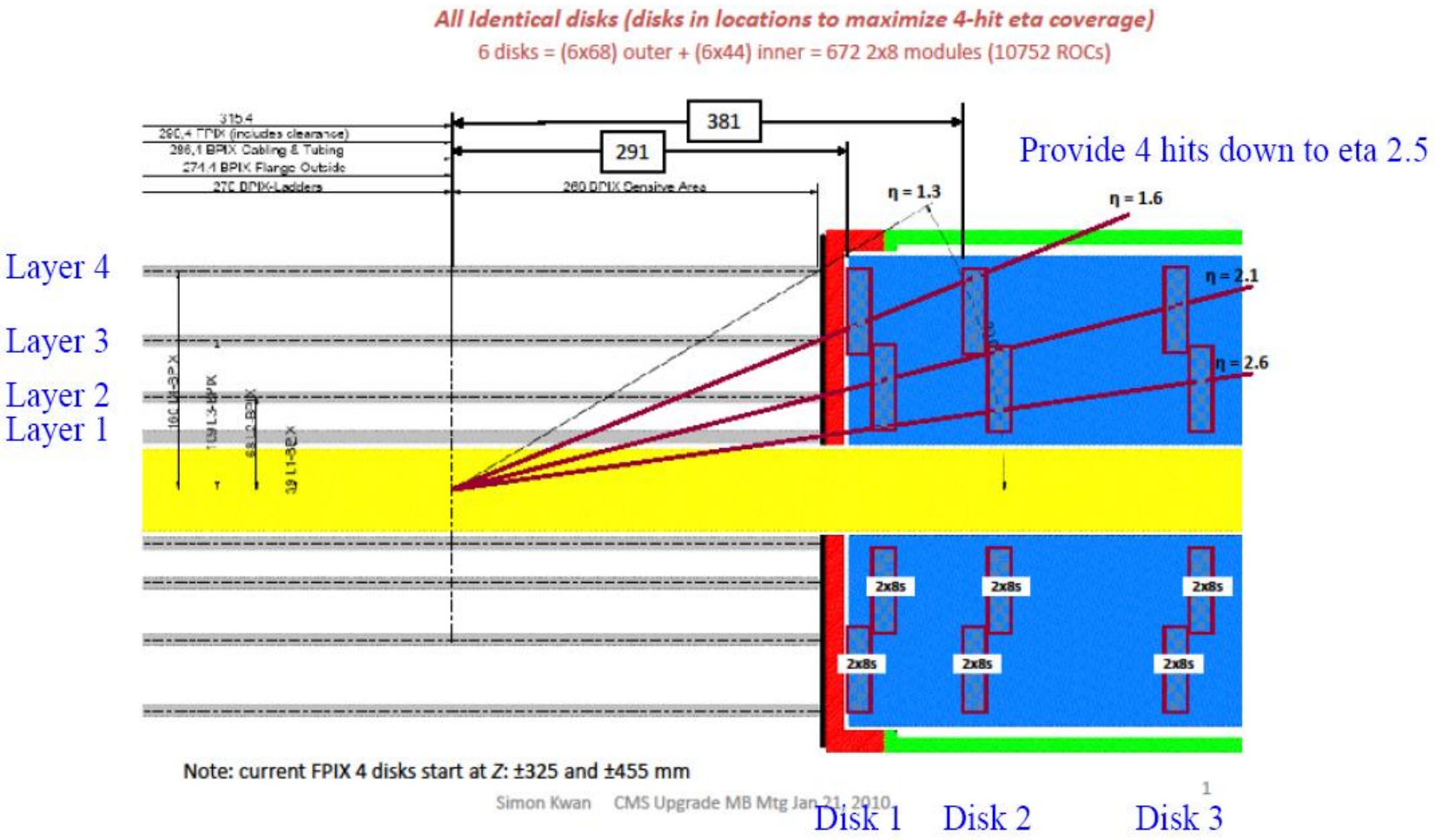
Timeline

- Almost a final TP ready for the whole CMS collaboration to review by Aug. 15th .
- Final touch up on Thu. Sep. 2nd TUSC/FB meeting.
- Final TP expected by CMS by Sep. 6th. (to be discussed at the Sept 22nd LHCC meeting)

CMS Improvements and Upgrades Timeline

Shutdown	System	Action	Result	Physics
2012	Hadron Outer	Replace HPDs with SiPMs to reduce noise	Single μ trigger Tails of very high p_T jets	Muons from τ $Z/H \rightarrow \tau\tau \rightarrow \mu X$
2012	Hadron Forward	Install new PMT to reduce window hits	Forward jet tagging Improves MET	Vector-boson fusion H
2012	Muon YB4	New RPC CSC (not funded)	Improved trigger at lower thresholds	Increase W acceptance
2012	PLT	New diamond lumi-monitor	Improved lumi meas.	All
2012	Beam Pipe	Install new beam pipe	Easier pixel installation	b-tagging
2016	New Pixel system	Low mass 4 Layers, 3 Disks with new ROC	Reduces dead time Improves b-tag.	SUSY decay chains
2016	HCAL uTCA trigger	Replace HPDs with SiPMs for longitudinal segmentation New electronics	Reduces pileup effects Improves MET Improves τ, e, γ clustering and isolation	SUSY $H \rightarrow \tau\tau$ $H \rightarrow ZZ \rightarrow ll\tau\tau$
2016	Muon (ME42,ME11) uTCA trigger	CSC (Complex YB4 installation) New electronics	Improved μ trigger and reconstruction ($1.1<\|\eta\|<1.8$, $2.1<\|\eta\|<2.4$)	W acceptance WH, $H^{\pm} \rightarrow \tau\nu$
2020	TRACKER New Trigger Endcap Calo.	Replace tracker Replace trigger	Maintain performance at high SLHC Lumi	Guided by early discoveries

2016 Pixel Upgrade



Features of the 2016 Pixel Upgrade

New Layout

- Add a 4th Layer (radius 160 mm) much closer to the TIB wrt present 3rd Layer (106 mm)
  - Improve track seeding efficiency
    - Improved Tracking and HLT performance (pixel tracks can be found quickly)
    - Increase redundancy and robustness of pattern recognition
    - Improved Tracking performance in core of high pt jets
- Reduce Inner Layer Radius (from 44 to ~ 39 or 34 mm to be evaluated) with a new beam pipe 25 mm
  - Improve b-jet tagging
- Reduce Read-Out Inefficiency of present ROC
  - Improve Read-Out Efficiency at ~ $2X10^{34}$
- Reduce aggressively the Material Budget
  - Decrease the amount of multiple scattering, photon conversions and nuclear interactions.
    - Improve Impact Parameter Resolution and Tracking efficiency
- Evaluate reduction of Pixel size in Inner Layers
  - Reduce dependence on charge sharing and maintain resolution with radiation
  - Improve b-jet tagging
  - Improve seed efficiency and quality in very dense environment
    - Improved Tracking performance in core of High Pt jets, increased robustness

Phase 2 Tracker Upgrade

- Discussion on Tracker Upgrade for Phase II is advancing.
- Plan to replace the Tracker in ~ 2020. TDR 2013-14(?). Lots to do.
- Several R&D activities are ongoing. Few others need to start.
  Very good synergies/overlaps with developments for Phase I.

- Sensors
- Optical link
- Power System
- Cooling system
- Triggering Layers
- Front-End chips
- Mechanics and materials

- A Draft R&D plan for the next 3-4 years is in preparation and will be part of the Technical Proposal Phase I.

R&D activities for the Full Tracker Upgrade

July 20, 2010

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